RhinoCAM & Architectural Design Meet Head-On!

Company Background

LMN Architects, located in Seattle Washington, began as a small architectural firm 35 years ago and has since grown to employ over 130 professionals and it's very easy to see why. Their projects include large scale government institutions such as performing arts and conventions centers, universities and office buildings. Currently, they are working on the Washington State convention center expansion. But it doesn't stop there. LMN has also designed modern deco art for local storefronts and even smaller projects such as modular displays for local charity events.

A Fusion of Technologies

One would think that the use of CNC machining in an architectural design firm would be limited to traditional applications such as model making. Think again, as Scott Crawford, Associate Architect for LMN explains.

> *"Our goal is to explore ways of fusing new technologies or those traditionally of other industries and demonstrate how we can use them within the architectural process. Specifically, how we can incorporate CNC into the way we think about design and how we approach design studies, in addition to building models and prototypes."*

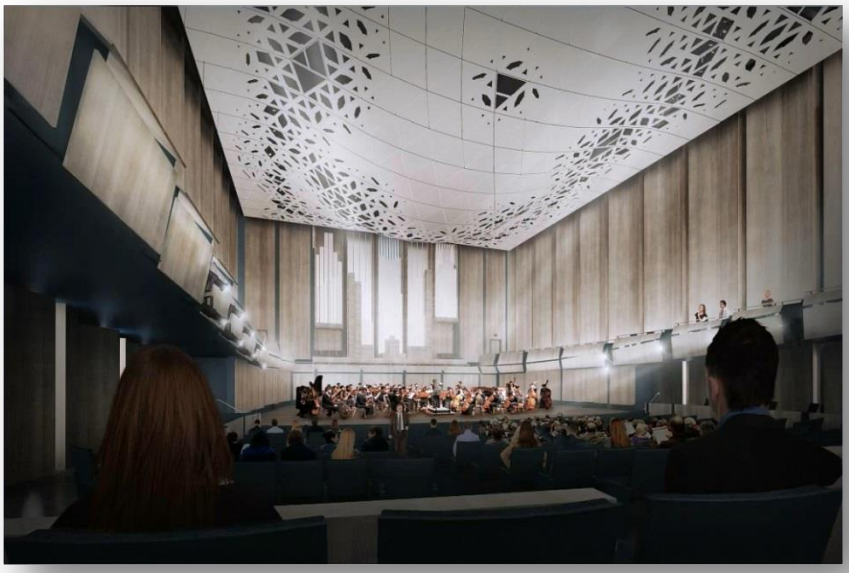
Why RhinoCAM?

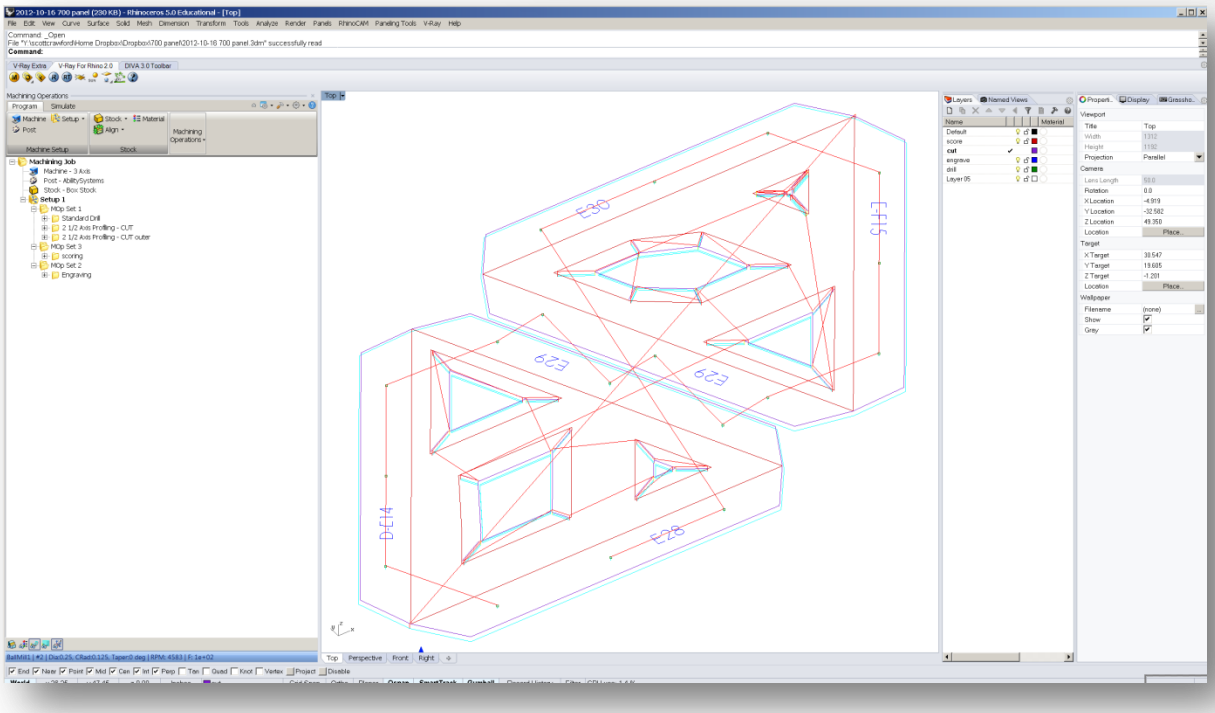
LMN Architects employs Rhinoceros 5 coupled with Grasshopper for graphical algorithmic design studies, Autodesk Revit for drafting and documentation and RhinoCAM for CNC machining.

> *"Rhino is really great for doing early design studies because it can crank through many iterations quickly, much faster than with Rivet. Also, for many designs, we are using Rhino all the way through the entire process to generate construction documents. I've done a lot of teaching at the University of Washington and RhinoCAM was the tool we were using there in addition to Mastercam. It is so much easier to teach someone how to use RhinoCAM. It meets all of the needs that we have. We can quickly get the modeling work done within Rhino and go straight to generating toolpaths. Also, I've found that the interface and workflow is just easy and intuitive, removing the complexity of creating toolpaths."*

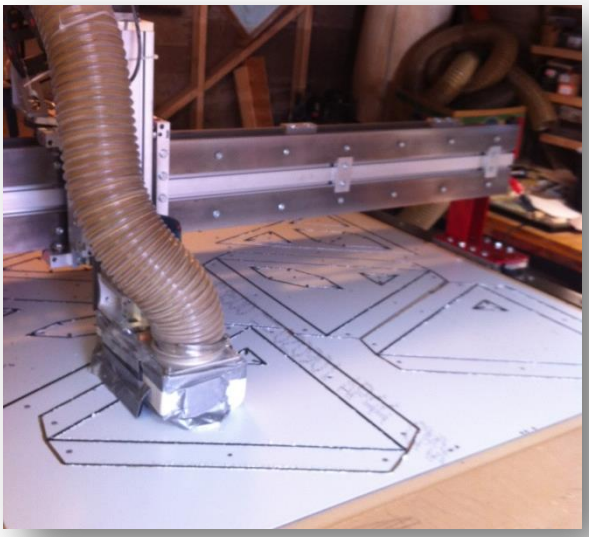
Architectural Design

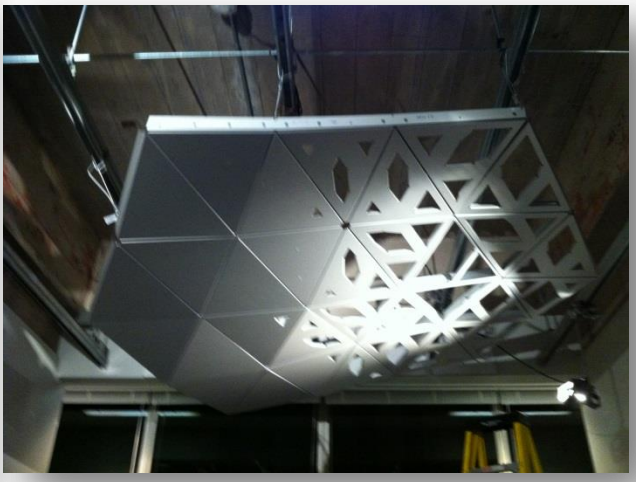
In this project, LMN is building a 1/3 scale mock up for a ceiling system for a large performance hall. The production material is an aluminum composite panel or ACM, composed of two skins of aluminum with a plastic inner layer. The triangular panels include tabs on each of the edges that end up getting folded up as you see below.





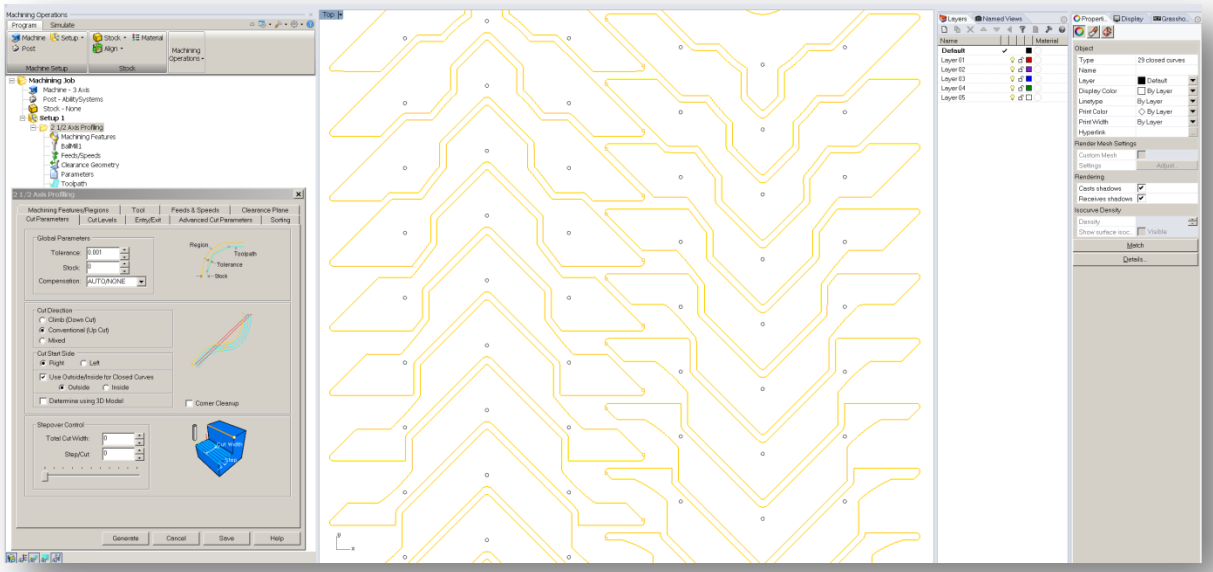
Thirty two of the panels were machined out and brought into the office and assembled as you see in the images below. The solid areas are used reflect sound back down into the space below and the open areas are used to allow sound and light to pass through. As you can see, the functional design becomes more of an overall expressing of the ceiling. It was very important on this project to be able to make a mockup of the system they were imagining so that they could convince the others that the material system they were proposing would do the job.

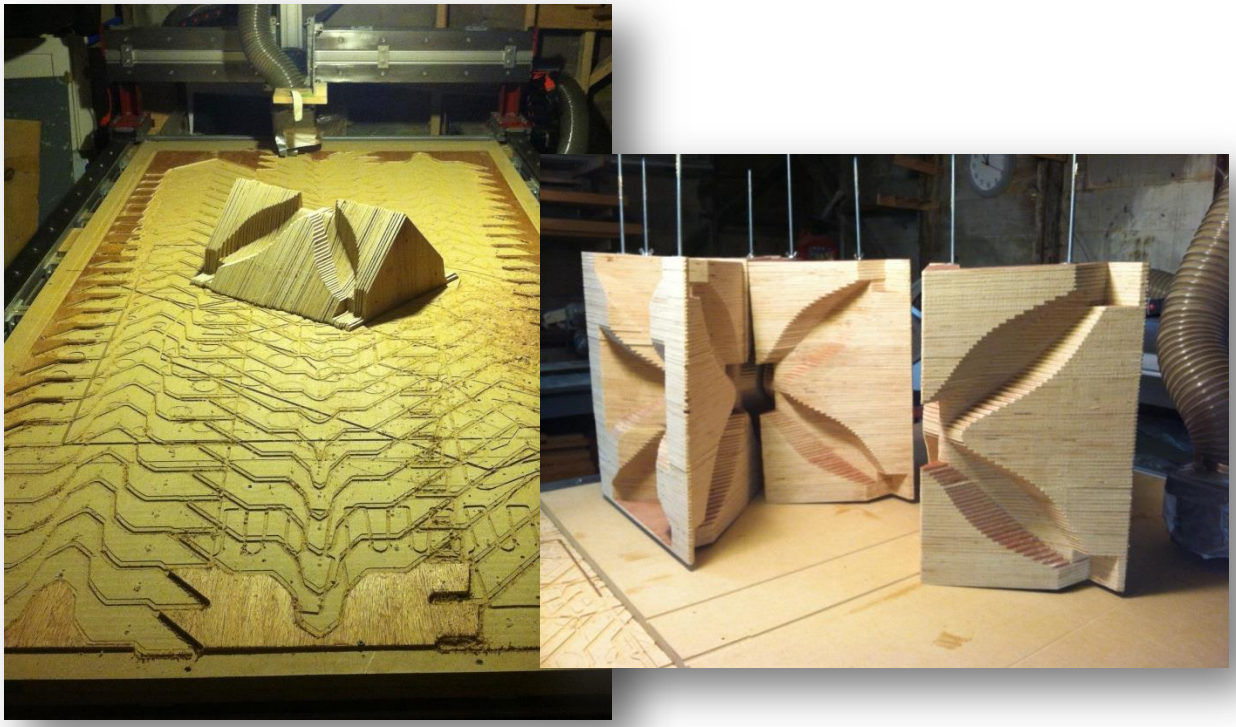




Research Experiments

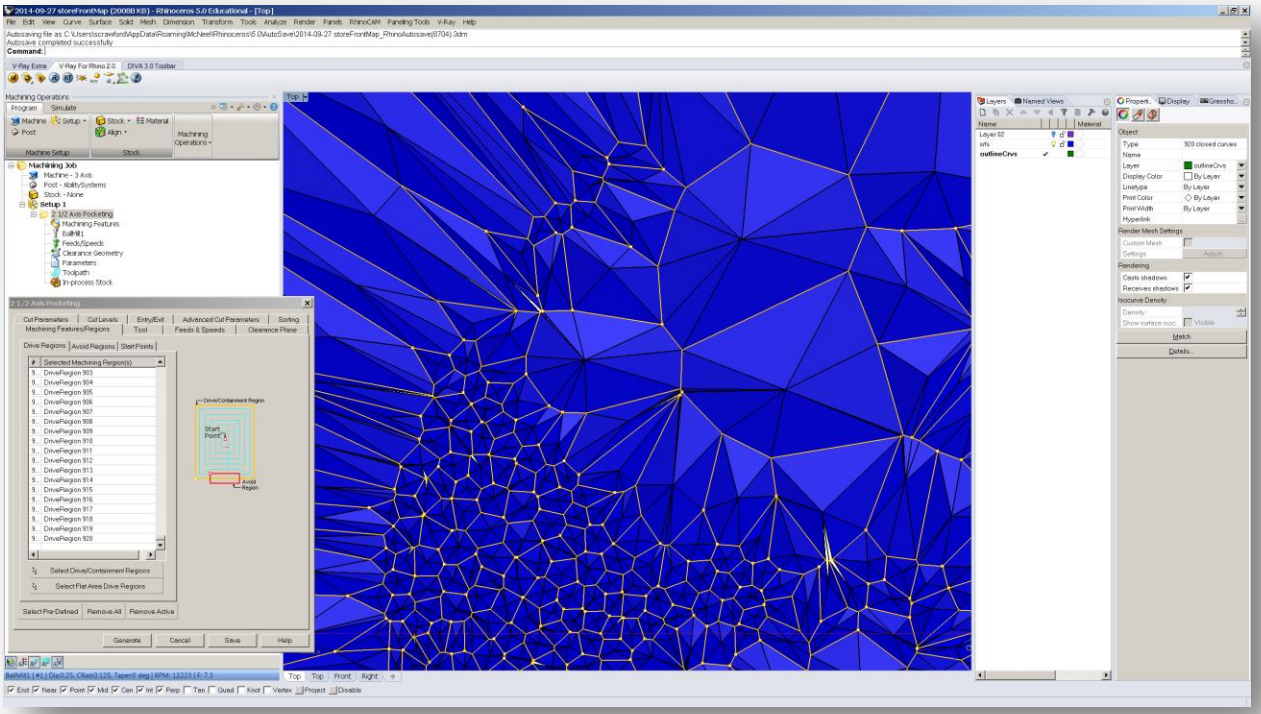
In this project, the final assembled design is actually a 4-piece concrete mold composed of 83 staked profiles milled of wood sheeting designed in such a way that when assembled, forms the decorative shape that you see in the images below. The parametric design and arrangement of the parts were done in Rhino Grasshopper and then machined using RhinoCAM.





Art Deco Design

This project was created for a group called *Seattle Store Fronts* who does art projects in abandoned storefronts around the city of Seattle. The overall design is 8x8 feet milled out of 1/4 inch thick acrylic. Each of the border shapes were modeled and extruded toward its center to a depth of 1/8 of an inch. Then RhinoCAM was used to generate horizontal toolpaths using a ball end mill with a large enough step-over so that the tool's shape is visibly expressed in each shape.



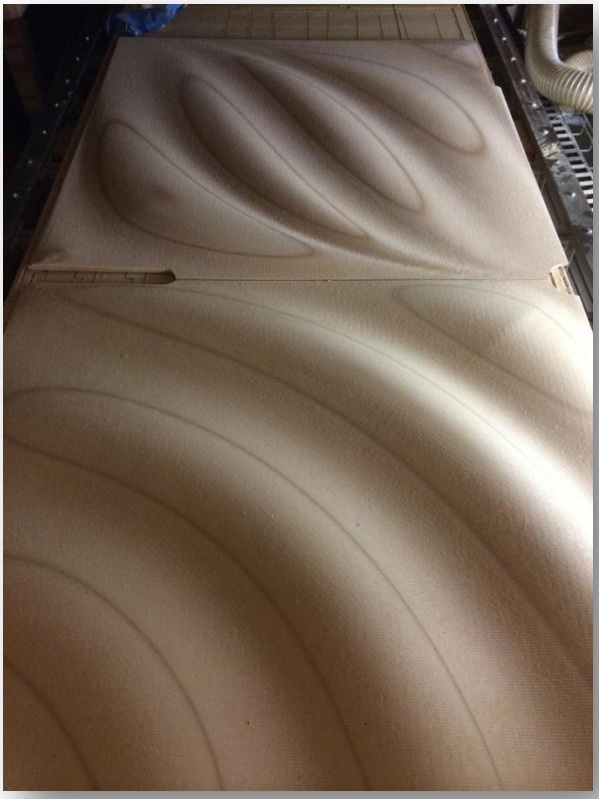
The colors are all coming from rear projection. When you route acrylic it leaves a frosted appearance that essentially allows light to *stick* to the surface. The design is actually an interactive abstract of the city of Seattle that changes based on your viewing location from the street.

Modular Displays

This modular display was a quick 3-week project for a golf tournament that the LMN office was participating in as one of the sponsors. As you can see it's a modular put-put golf course machined from Medium Density Fiberboard or MDF. Each of the quadrants is a 4x4 foot section, with different highly sculpted 2-1/2 inches of shaped elevation. The models were designed in Rhino Grasshopper and the toolpaths generated with RhinoCAM's 3 Axis Parallel Finishing operation using a 1/4" ball mill with a 0.05 step-over.

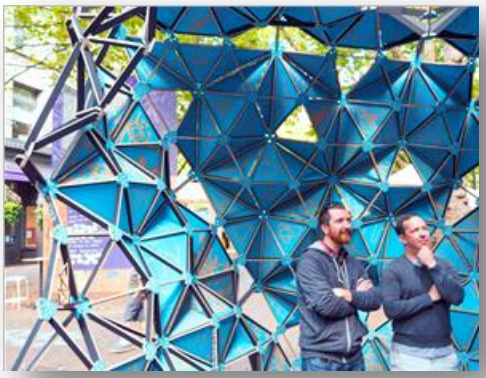
"The nice thing is that the software doesn't get the way and makes it very easy to pull something like this off in a short amount of time. It's very simple to take and model all of these parts in Rhino Grasshopper and then push them into RhinoCAM as soon as we're ready."

If you're wondering how he achieved the decorative edging around each of the sculpted elevations – it's actually the glue joints between the bonded layers of MDF.



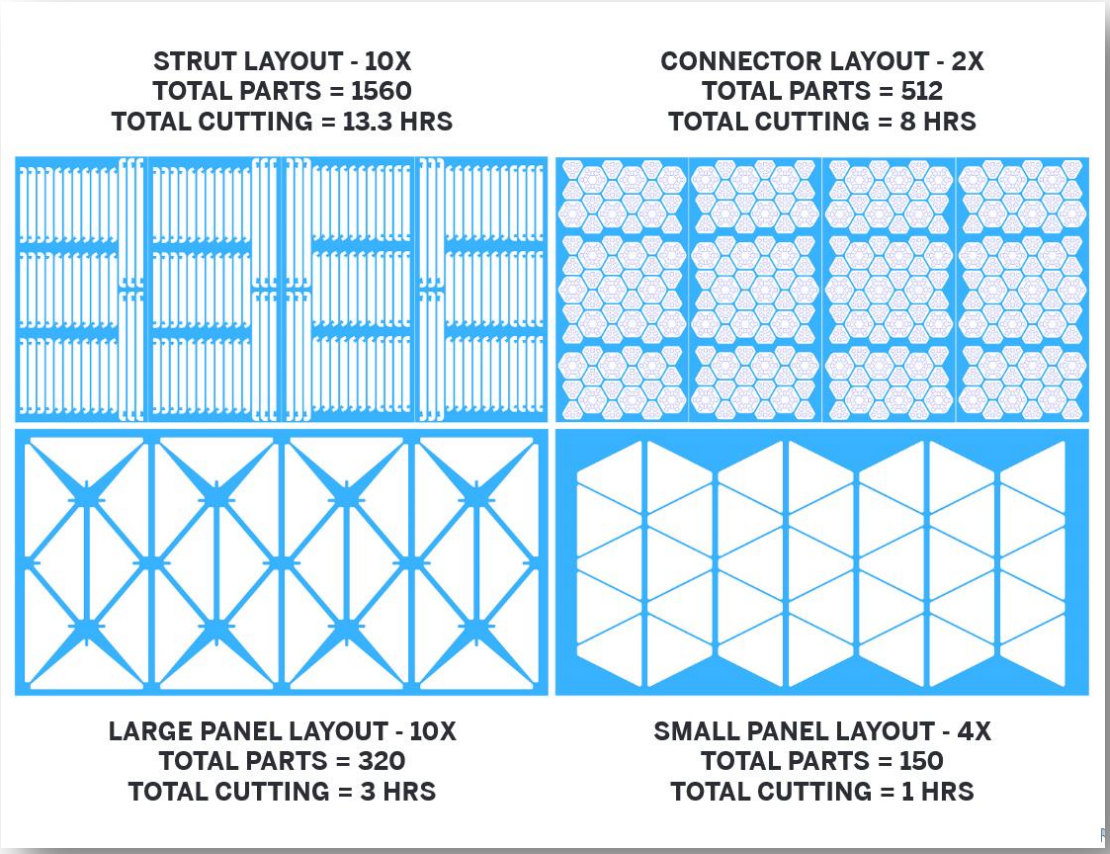
The Seattle Design Festival Pavilion

This self-supporting octahedron project is a pavilion that LMN designed and assembled for the **Seattle Design Festival** in 2013. The entire structure is a "friction-fit" assembly, no screws; no glue was used in the entire structure. We used Rhino for the design and machined all of the parts out using RhinoCAM.



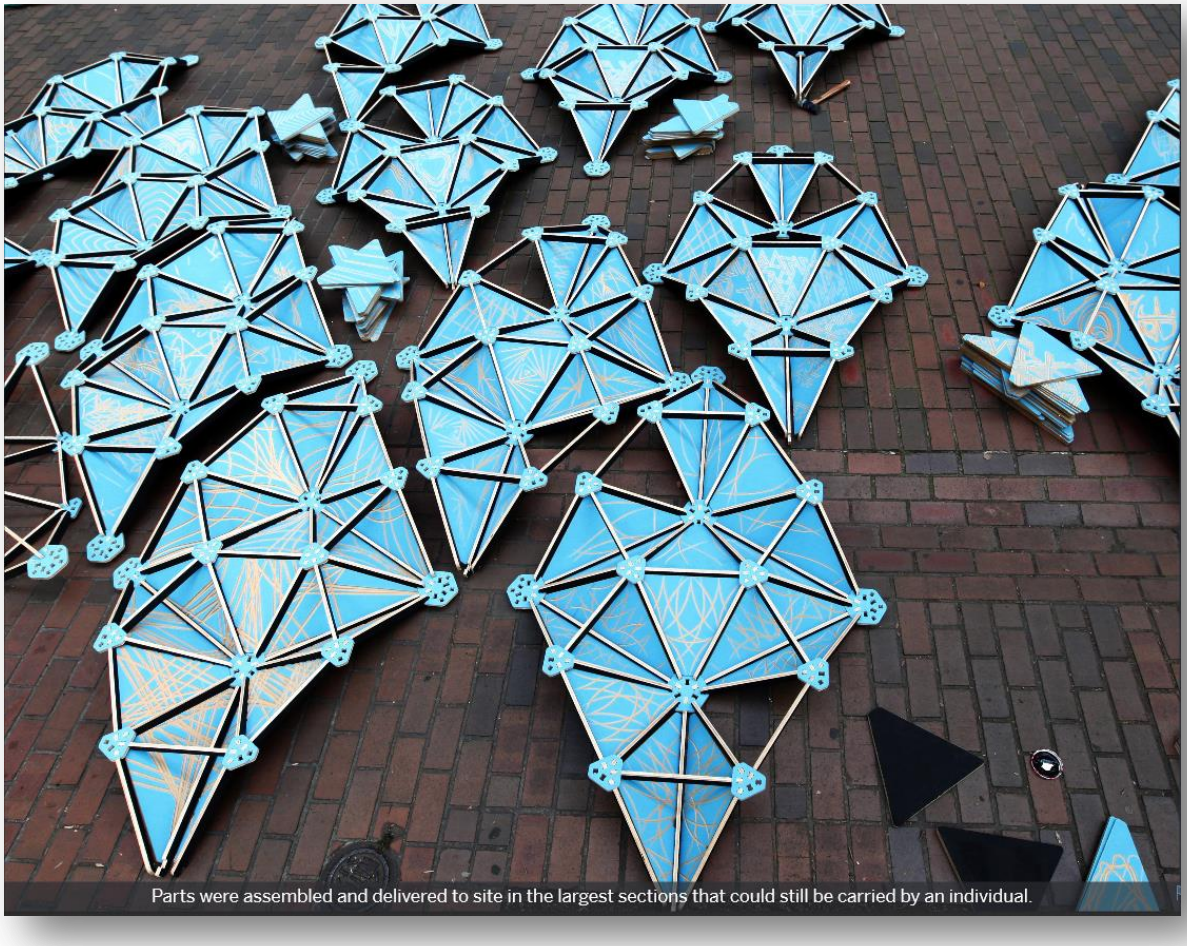
The project was also used as a training exercise in the LMN office to help other members of the team become familiar with how to go about modeling something within Rhino and then taking it into RhinoCAM to generate toolpaths.

The important thing in this project according to Scott was RhinoCAM's ability to automatically create bridge points to hold all of these pieces in place within each 4x8 sheet. No vacuum table was used. The nesting of the parts and the bridge points designed in RhinoCAM allowed each part to be held in place just long enough until the next piece is cut, thus removing the bridge points from the previous cut.



So what are the blue panels? Each participating individual in the office was provided a Rhino template consisting of 9 panels and were encouraged to draw a pattern of lines in a display of unique expression.

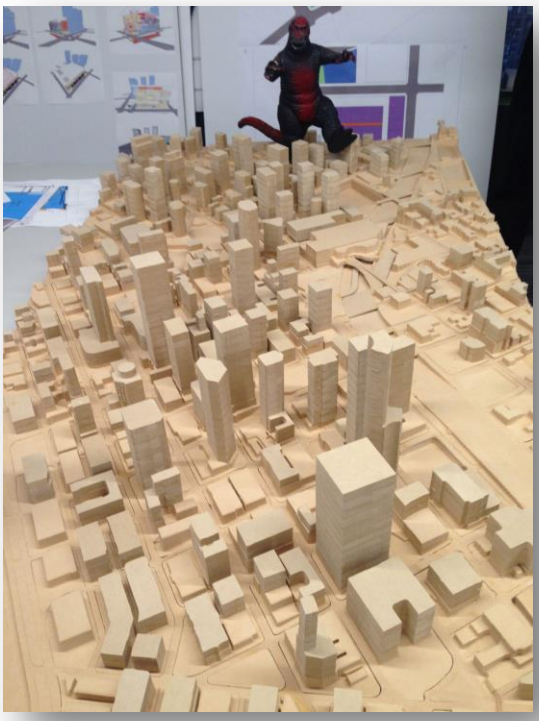
Rhino Grasshopper was then used to modify every curve so that it started at the surface and plunged a maximum of 1/8 of an inch into the surface and then gradually come back out in a feathering pattern on each end. We then showed them how easy it was to use RhinoCAM to generate engraving toolpaths and the g-code necessary to cut each of their unique panels.

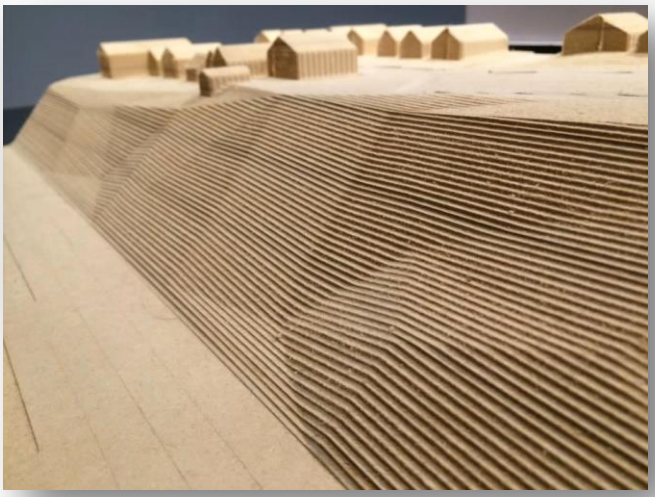


Parts were assembled and delivered to site in the largest sections that could still be carried by an individual.

Site Model Displays

In a more traditional application, LMN created a site model of downtown Seattle using GIS data for size and elevation for all of the building, streets and topography. After refining the GIS data is Rhino, RhinoCAM was then used for machining. First a roughing pass was used to take it down close to the actual surface leaving 1/4 of an inch. After that a parallel finishing pass was used with step-over of 1/32 of an inch to achieve the final topography. In other areas we would play on the texture using the toolpaths. For example, a larger flat end mill tool was used with a larger step-over to achieve the texture seen on the hillsides.





About LMN Architects

George Loschky, Judsen Marquardt and John Nesholm founded LMN in 1979. Their shared vision for the firm was a focus on community projects. They were inspired by the potential for projects in the public realm to contribute to society by enhancing their communities and developing a vision for a vibrant future for our cities. To this day, LMN's distinctive cultural arts venues, convention centers, higher education facilities and transit stations enrich civic life throughout the United States and beyond.

Learn more about RhinoCAM at Mecsoft.com.